ANNUAL REPORT - 1959

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CHAPARRAL CONTROL PROJECT

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by

D. T. Lillie

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Service
Crops Research Division
Crops Protection Branch

Rocky Mountain Forest and Range Experiment Station
Arizona State University
Tempe, Arizona

SUMMARY OF FINDINGS

None of the experiments have been carried to completion at this time. Following is a list of findings based on apparent topkill of turbinella oak:

1. The phenoxy herbicides 2,4,5-T and silvex result in rapid kill of leaves and defoliation with varying amounts of topkill of branches.
2. Sprouting of oak plants has invariably resulted from single applications of 2,4,5-T and silvex up to eight lbs/acre.
3. PBA and TBA are powerful growth inhibitors of turbinella oak, this inhibition has persisted for at least one year following applications of four and eight lbs/acre.
4. Silvex and 2,4-D at two or four lbs/acre were successful in reducing the fuel moisture content of oak leaves from approximately 70 down to 10 percent of dry weigh in six weeks time. The moisture content of the twigs was not then affected, but 110 days after treatment the fuel moisture content of small twigs had been reduced from 53 percent to below 30 percent by four lbs/acre of either chemical.
5. Soil application of granular or pelleted herbicides is a promising method for control of turbinella oak. The substituted ureas and benzoic acid compounds are most effective at the present time, although more time will be necessary to determine if kill of the plants will be obtained.
6. Silvex, 2,4,5-T, 2,4-D, and simazine have shown no activity as soil applied herbicides for the control of turbinella oak.

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INTRODUCTION

The following report concern activities and accomplishments of D. T. Lillie, Research Agronomist, for the year 1959.

The U. S. Forest Service has established a chaparral research group at Tempe, Arizona, to gather data on various aspects of that portion of Arizona rangeland known as the chaparral type. A major portion of that research is to investigate the possibility of increasing the water yield of chaparral watersheds by manipulation of the plant cover. To this end the Forest Service has enlisted the aid of the Agricultural Research Service to investigate methods of controlling chaparral species in general and turbinella oak (*Quercus turbinella*) in particular.

We are quartered in a Forest Service building which in turn is located on the Arizona State University campus at Tempe, Arizona. We utilize Forest Service office help, and Forest Service office, laboratory, and greenhouse space. Thus, the agronomist must of necessity work s in close cooperation with the Forest Service chaparral project. This means not only the mutual interchange of information and cooperative studies, but also the it has been necessary to attend ance of many Forest Service meetings and field trips for the purpose of informing interested parties and agencies of the ARS segment of the overall chaparral project.

The Chaparral Type

The usual chaparral vegetation in Arizona characteristically grows in thickets on the foothills between the grassland type and the woodland type. There is no sharp line between the types of vegetation, but rather a gradation with the types interspersed. The chaparral is usually composed of one or two dominant species with lesser amounts of one or more secondary species. Differences in soil, slope, exposure, elevation, and moisture conditions produce variations in stand composition. Turbinella oak, which is most often the dominant species, frequently comprises 60 to 90 percent of the plant cover.

The chaparral lies generally in the 3,000 to 6,000 foot elevation range with an annual rainfall of approximately 12 to 25 inches. Rainfall in the chaparral belt in Arizona is devided into two rainy seasons, although some rain may occur in every month of the year. The major winter rainy season is during the December through March period with the majority of the summer rain falling in July, August, and September. The winter rains are characteristically frontal rains while the summer rains are usually the result of thunderstorms.

The soils in the chaparral belt are for the most part unclassified. They are poorly developed residual soils derived from granite, slates, and shales.

A study now in progress at the University of Arizona will attempt to classify the soils in the chaparral belt. An attempt is being made there to explain the presence or absence of turbinella oak on various sites by the soil variation.

Research Sites

Two sites have been selected for field studies on chaparral control. The first is located near Dewey, Arizona, at an altitude of approximately 5,100 feet. The plots are located at a latitude of 34° 32' and a longitude of 112° 12'. This site is approximately 95 miles from Tempe, Arizona.

This site was selected for its relative uniformity of brush cover, accessibility, gentle slope and the occurrence of an adjacent burned over area. This enables simultaneous testing of herbicides on burned and unburned oak.

The only weather station near Dewey with comparable climatic conditions is located approximately 15 miles southeast of Dewey at a somewhat lower elevation. Twenty-year records for this station indicate anannual average rainfall of 18.2 inches with approximately 40 percent of the total occurring in the December through March period and 40 percent in the July through September period.

April 17 is the average date of last spring frost and October 31 is average date of first fall frost. The station has a growing season of 197 days.

The second site is located near Tonto Springs, Arizona, approximately 120 miles from Tempe, at an elevation of approximately 4,600 feet. The plots are located at a latitude of 34° 36' and a longitude of 112° 40'. This site was also selected for accessibility, uniformity, and gentle slope.

A weather station is located within 2 miles of the plot area. Twenty-year data for this station indicate an annual average rainfall of 18.7 inches with 37 percent in the December through March period and 42 percent in the July through September period.

Annual average frost free period is from May 8 to October 16 with a 161 day growing season.

INDIVIDUAL EXPERIMENTS

All experiments are under line project CR-f1-27: Develop Methods of Controlling Woody Plants on Arid Pasture and Range Lands.

Experiment Number 1

Title.--Evaluation of various herbicides applied as foliage sprays at four seasons of the year.

Background.--The use of foliar sprays for the control of turbinella oak has been generally disappointing. It has been possible to obtain some degree of topkill with several of the phenoxy derivatives, the low volatile esters of 2,4,5-T and silvex in particular. This topkill is invariably followed by vigorous sprouting from any unkilled portion of the plant, but particularly from the "crown" (stem tissue at, and below ground level) of the plant.

It is the purpose of this experiment to explore the possibility of improving control of turbinella oak with the phenoxy herbicides, as well as other herbicides and combinations of herbicides, by application in various seasons of the year. The exact date of application within each of the seasons was not specified, but was to be determined by phenological and climatological considerations at the test

site. Tests were to be applied at periods of rapid growth corresponding to adequate soil moisture in the spring and following summer rains. A second pair of tests were to be applied at a time when growth is restricted by lack of moisture in the fall and when growth is inhibited by cold temperatures in the winter.

Tests were applied during September of 1958 and March of 1959 the first date corresponding to the "growth flush" following summer rains and the second corresponding to a "winter dormant" application.

Objectives.--The objectives of this study are to provide information pertaining to:

a. Susceptibility of turbinella oak to various herbicides.

b. Approximate effective rate of herbicide.

c. Effect of season of application.

d. Possible interaction of herbicides with seasons of application.

Materials and Methods.--All spray solutions were delivered from a 25-foot spray boom mounted on an Oliver OC-4 crawler tractor. The applications were made at 30 pounds per square inch pressure at a gallonage of 20 gallons per acre. Two milliliters of Colloidal X-77 wetting agent were added per gallon of spray mixture.

The following herbicides or combinations of herbicides were applied on the September 1958 date of application:

Herbicide	Lbs/Acre
Check	0 and 0
2,4,5-T	2 and 4
Silvex	2 and 4
2,4,5-T + ATA	$1\frac{1}{2}+\frac{1}{2}$ and $1\frac{1}{2}+1$
TBA + ATA	3+1 and 6+2
ATA (Liquid formulation)	4 and 8
PBA	4 and 8
TBA	4 and 8
Cacodylic acid	3 and 6

Of these herbicides TBA plus ATA, ATA, TBA, and cacodylic acid were applied in aqueous solution and 2,4,5-T, Silvex, and 2,4,5-T plus ATA were applied in a 1:2 diesel oil in water emulsion. The PBA application was made in diesel oil.

These treatments were made to 25 x 40 foot plots in 3 replications of a split plot field design. The test was applied to mature, undisturbed chaparral comprised almost exclusively of turbinella oak. The entire experiment was repeated on fire sprouts in an adjacent area which had been burned in June of 1958 and reseeded to perennial grasses.

The March 1959 application was identical to the September application except that 8 and 16 lbs/acre of dalapon was substituted for the cacodylic acid which was essentially inactive.

Results and Discussion.--The effect of season of application upon relative efficacy of herbicidal applications to turbinella oak is difficult to detect. None of the applications result in actual kill of the plants and the amount of topkill and defoliation is a constantly changing picture. The rate and extent of recovery of the oak plant is also influenced by the climatological conditions following treatment. The recovery of a plot sprayed in May, for instance, would be more rapid than one sprayed with the same herbicide in October. If one were evaluating these two plots the following spring he would not know whether the differences were due to season of application, length of time since spraying, or the fact that the May treatment had a summer growing season in which to recover. If one evaluates plots a year following application so that all plots are allowed an equal chance of recovery, there is essentially no effect left to evaluate.

Therefore, this test has not provided any information on the effect of season of application upon control of turbinella oak. Furthermore, the test, as designed and with the chemicals now in use, probably will not yield much information on the season effect. In view of the inadequacy of this test to serve its original purpose, and the fact that the unburned portion of the test was the victim of a June 1959 fire, the test has been discontinued in its original form.

It is now proposed to retreat the remaining portions of the test one year following the original application and glean some information on the activity of the herbicides and combinations of herbicides involved. The test on the season effect per se will be redesigned and simplified.

The results (Tables 1 and 4, Appendix Table 1) of the original (September 1958) application to fire sprouts of turbinella oak illustrate the rapidity and extent of recovery of turbinella oak after treatment with the phenoxy derivatives. For instance the apparent topkill of oak with four pounds of silvex was 93 percent four months after application, 36 percent nine months after application, and three percent after one year.

The percent apparent topkill figures resulting from treatment with the benzoic acid derivatives were equally, or perhaps more, unimpressive. An indication of the growth suppression exhibited by these herbicides may be found in figure 1 . While the oak sprouts are not dead, they have made very little growth since the original application of TBA and PBA. The silvex and 2,4,5-T treatments, on the other hand, have made considerable growth although all the leaves, along with many of the stems, shown in the picture are dead. The ATA treated plots are intermediate between these two regrowth extremes. Considerable chlorosis was evident with this herbicide one year after initial application.

The effect of the combination treatments is not yet clear. The combination of ATA with 2,4,5-T does not appear to offer any advantage over the 2,4,5-T alone. The combination of ATA with TBA may be better than either herbicide alone. Such critical evaluation will have to wait until such time as a more detailed experiment (now being planned) can be put into effect.

The cacodylic acid treatment was ineffective.

The action of the chemical to the unburned oak (Tables 2 and 5 and Figure 2) was somewhat more spectacular due to the fact that there was a greater amount of material present to topkill. The regrowth, which was about as profuse as on the burned oak, was relatively inconspicuous when the bush was viewed as a whole. This phenomenom is responsible for the much higher percent apparent topkill shown for the unburned oak when both fire sprouts and unburned oak were treated and evaluated at the same time.

The results of the application made on March 2, 1959 (Tables 3 and 6, Appendix Table 2, and Figures 2 and 3) are preliminary at this time. These results only serve to emphasize those obtained with the first application, although it is possible that eventual comparison of these two treatment dates may provide some information on season effects.

The application of dalapon had a surprising effect on oak with almost complete defoliation resulting (Figure 2) and some definite formative effects (Figure 3) present on the regrowth. Figure 3 illustrates very well the topkill and defoliation obtained with silvex.

Another evaluation of the fire sprout test will be made prior to the planned retreatment in March of 1959.

It is unfortunate that the unburned portions of these tests were destroyed by fire as a direct comparison of application to fire sprouts and unburned oak would be valuable. Observation of these plots following the fire showed some definite formative effect on

regrowth of these plants treated with the benzoic acid derivatives. However, since the fire was quite spotty in nature and many of the plots were not burned it would be impossible to get valid comparisons of any inhibition of regrowth that may be present.

Table 1.--Percent apparent kill of fire sprouts of turbinella oak on various dates after being treated with two rates of various herbicides on September 30, 1958, and retreated on September 24, 1959. Tempe, Arizona, 1959.

	Percent Apparent Topkill																	
Treatments	Check		Cacodylic acid		TBA		TBA + ATA		Liquid ATA		PBA		2,4,5-T + ATA		2,4,5-T		Silvex	
Pounds per acre	0	0	3	6	4	8	3+1	6+2	4	8	4	8	1½+½	1½+1	2	4	2	4
Evaluated 1/59	16	17	22	21	36	26	16	19	36	52	57	67	71	70	74	91	72	93
Treatment mean	16		22		31		17		44		62		70		82		83	
Evaluated 6/59	-	-	0	0	6	13	1	3	3	5	17	19	8	17	14	15	14	36
Treatment mean	-		0		10		2		4		18		13		15		25	
Evaluated 9/59	0	0	0	0	1	7	1	2	0	1	4	6	0	1	2	3	1	3
Treatment mean	0		0		4		2		1		5		1		2		2	
Evaluated 12/59	0	1	1	3	18	50	30	28	13	27	27	40	83	85	72	83	80	78
Treatment mean	1		2		34		29		20		33		84		78		79	

Table 2.--Percent apparent kill of turbinella oak on two dates after being treated with two rates of various herbicides on September 30, 1958. Tempe, Arizona, 1959.

Treatments	Percent Apparent Topkill																	
	Check		Cacodylic acid		TBA		TBA + ATA		Liquid ATA		PBA		2,4,5-T + ATA		2,4,5-T		Silvex	
Pounds per acre	0	0	3	6	4	8	3+1	6+2	4	8	4	8	$1\frac{1}{2}+\frac{1}{2}$	$1\frac{1}{2}+1$	2	4	2	4
Evaluated 1/59	5	7	10	12	17	24	11	19	36	33	17	50	55	72	82	97	84	96
Treatment mean	6		11		21		15		35		34		64		89		90	
Evaluated 6/59	-	-	2	5	10	30	12	30	18	17	17	33	52	53	73	82	83	90
Treatment mean	-		3		20		21		17		25		52		78		87	

Table 3.--Percent apparent topkill of turbinella oak three months after application of two rates of various herbicides to fire sprouts and unburned oak on March 20, 1959. Tempe, Arizona, 1959.

Treatment	Percent Apparent Topkill																	
	Check		TBA		2,4,5-T + ATA		Silvex		TBA + ATA		PBA		Liquid ATA		Dalapon		2,4,5-T	
Pounds per acre	0	0	4	8	1½+½	1½+1	2	4	3+1	6+2	4	8	4	8	8	16	2	4
Unburned oak	11	6	26	70	52	57	36	83	75	49	48	79	74	61	78	86	81	84
Treatment mean	8		48		54		59		62		63		67		82		83	
Fire sprouts	0	0	15	6	14	20	12	40	1	12	3	9	3	1	2	4	20	43
Treatment mean	0		10		17		26		6		6		2		3		31	

Table 4.--Duncan multiple range tests on treatment means of percent apparent kill of turbinella oak at various times after treatment of burn sprouts with two rates of several chemicals in September of 1958 and retreated in September of 1959. Tempe, Arizona, 1959.

Date of Evaluation	Treatment Means*								
	Check	TBA + ATA	Cacodylic acid	TBA	Liquid ATA	PBA	2,4,5-T + ATA	2,4,5-T	Silvex
January 1959	16	17	22	31	44	62	70	82	83
	--	Cacodylic acid	ATA + TBA	ATA	TBA	2,4,5-T + ATA	2,4,5-T	PBA	Silvex
June 1959	-	0	2	4	10	13	15	18	25
	Check	Cacodylic acid	Liquid ATA	2,4,5-T + ATA	TBA + ATA	Silvex	2,4,5-T	TBA	PBA
September 1959 (retreated)	0	0	0.5	0.5	1.5	2	2.5	4	5
	Check	Cacodylic acid	Liquid ATA	TBA + ATA	PBA	TBA	2,4,5-T	Silvex	2,4,5-T + ATA
December 1959	0	2	20	29	33	34	78	79	84

* All means not underlined by the same line differ at the five percent probability level.

Table 5.--Duncan multiple range test on treatment means of percent apparent kill of unburned turbinella oak on two dates after a September 1958 treatment with two rates of various herbicides. Tempe, Arizona, 1959.

Date of Evaluation	Treatment Means*								
	Check	Cacodylic acid	TBA + ATA	TBA	PBA	ATA	2,4,5-T + ATA	2,4,5-T	Silvex
January 1959	6	11	15	21	34	35	64	89	90
	-	Cacodylic acid	Liquid ATA	TBA	TBA + ATA	PBA	2,4,5-T + ATA	2,4,5-T	Silvex
June 1959	-	3	17	20	21	25	52	78	87

* All means not underlined by the same line differ at the five percent probability level.

Table 6.--Duncan multiple range tests on treatment means of percent apparent topkill of turbinella oak three months after application of two rates of various herbicides to fire sprouts and unburned oak on March 20, 1959. Tempe, Arizona, 1959.

Type of Plant	Treatment Means*								
	Check	Liquid ATA	Dalapon	TBA + ATA	PBA	TBA	2,4,5-T + ATA	Silvex	2,4,5-T
Fire sprouts	0	2	3	6	6	10	17	26	31
	Check	TBA	2,4,5-T + ATA	Silvex	TBA + ATA	PBA	Liquid ATA	Dalapon	2,4,5-T
Unburned oak	8	48	54	59	62	63	67	83	83

* All means not underlined by the same line differ at the five percent probability level.

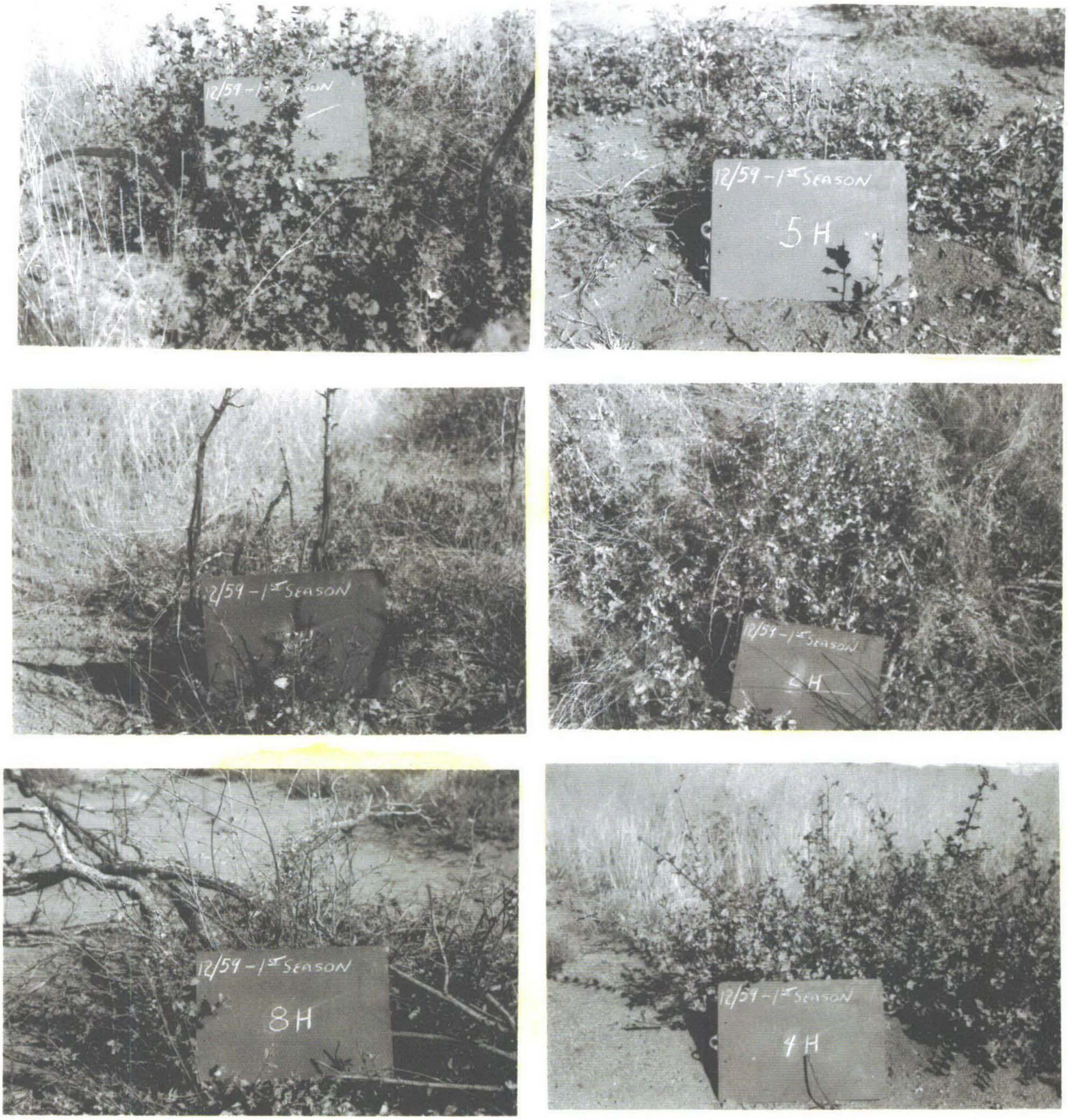

Figure 1.--Photographs taken 14 months after treatment of fire sprouts of turbinella oak with various herbicides on September 30, 1958. Plots were retreated on September 24, 1959. From left to right: upper row, check and 8 lbs/Acre liquid ATA; middle row, 8 lbs/Acre TBA amine and 4 lbs/Acre 2,4,5-T; lower row, 8 lbs/Acre PBA and 4 lbs/Acre silvex.

Figure 2.--Mature, unburned chaparral on June 16, 1959, after no treatment and treatment with 2,4,5-T and silvex on September 30, 1958 (left-verticle row, top to bottom) and with Dalapon, 2,4,5-T, and silvex (right-vertical row, top to bottom) on March 2, 1959.

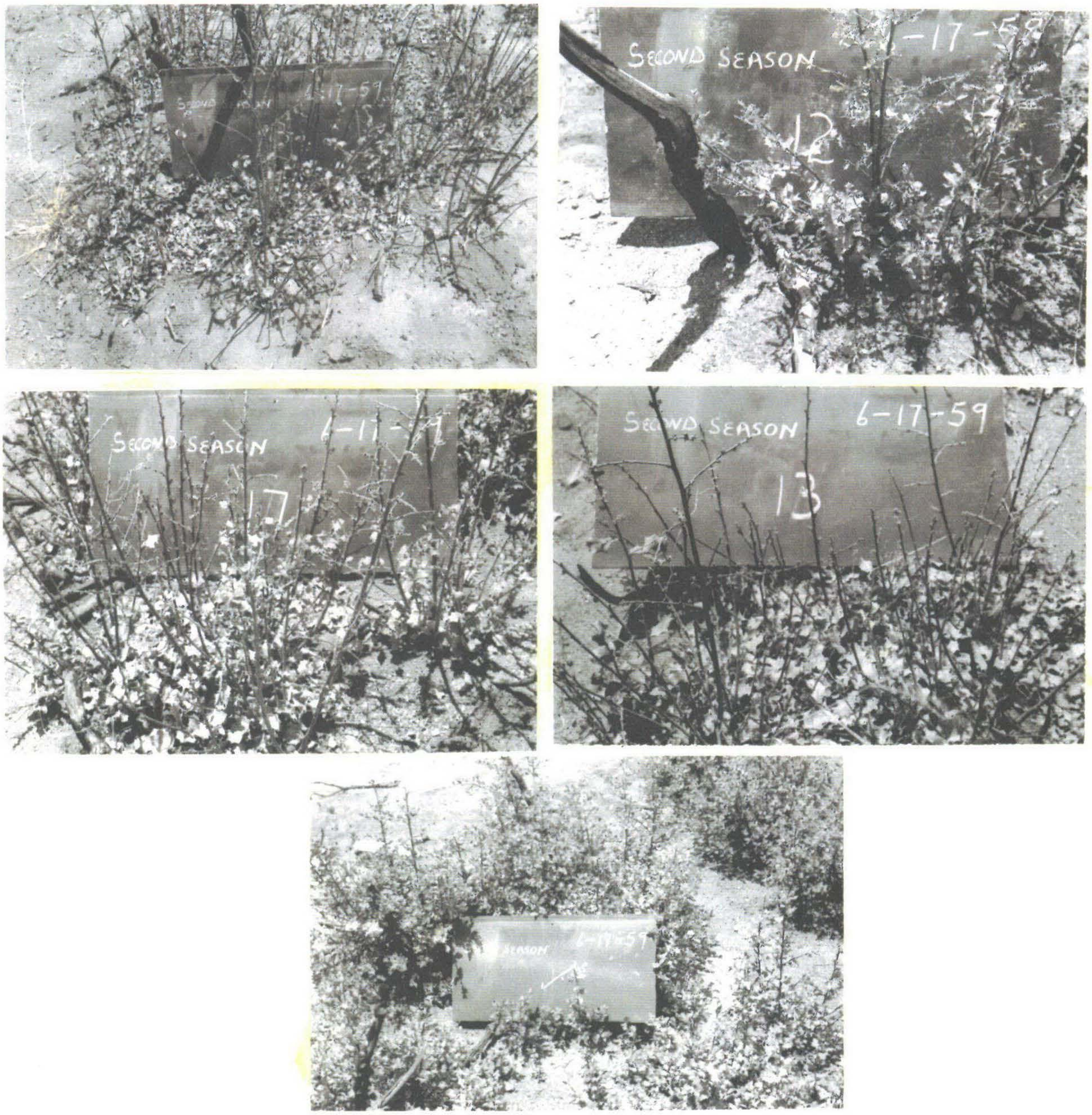

Figure 3.--Photographs showing turbinella oak on June 17, 1959, after a March 2, 1959 treatment with silvex (top left), Dalapon (center left), TBA plus ATA (top right), TBA (middle right), and no treatment (bottom).

Experiment Number 2

Title.--Effect of various emulsion ratios and two surfactants on control of turbinella oak with 2,4,5-T.

Background.--This exploratory experiment was prompted largely by observations of E. A. Davis working with fungicides to control pathogens on turbinella oak in propagation chambers. It was Dr. Davis' observation that several fungicides were considerably more damaging to turbinella oak sprouts when General Chemical's "Plyac" or Colloidal Chemical's "X-77" surfactants were added to the fungicidal solution.

The effect of oil/water emulsion ratios has not been investigated for turbinella oak control and my previous foliar applications have been applied in an oil in water emulsion containing a high concentration of oil. These high concentrations of oil were employed in an effort to obtain maximum phytotoxicity of the herbicidal applications. This test was further designed to compare 2,4,5-T applications carried by various emulsion ratios.

Objectives.--This experiment was initiated for the purpose of comparing 2,4,5-T applications with and without the addition of surfactants. The experiment was also intended to evaluate the efficiency of various oil/water emulsion ratios as carriers of the herbicide as well as any interaction that might exist between emulsion ratios and surfactants.

Materials and Methods.--A common herbicide treatment of three pounds per acre of 2,4,5-T was applied to all plots with the exception

of the check plots. This treatment was applied in a pure water emulsion and in diesel oil/water emulsion ratios containing 5, 10, 20, and 40 percent oil. These treatments were applied without surfactant and with two milliliters per gallon of Colloidal Chemical's "X-77", and with two milliliters per gallon of General Chemical's "Plyac".

The applications were made from a 25-foot boom mounted on an Oliver OC-4 crawler tractor. The pressure in the boom was 30 pounds per square inch and the spray solution was delivered at a volume of 20 gallons per acre.

Spraying was done on a clear sunny day with low relative humidity. The temperature ranged from approximately 65°F early in the morning to approximately 80°F in the afternoon. There was relatively little wind ranging from none to a gentle breeze.

The experiment was applied October 14, 1958, to 25 x 40 foot plots in four replications of a randomized block experimental design.

Results and Discussion.--Data were taken on this experiment on June 16, 1959, approximately eight months following treatment (Table 7). Since the area was burned over the following day it has not been possible to get further information. The data consisted of a visual estimate of apparent topkill. The estimate was made independently by two evaluators and an average taken of the two evaluations.

Since the evaluations were in percent topkill the data was transformed by the arcsin method prior to statistical analysis. The check plots were omitted from the analysis of the data. A summary of the analysis of variance is shown in Appendix Table 3.

It is apparent in this experiment that some oil in the emulsion results in more effective control of turbinella oak with 2,4,5-T. The comparison of no oil versus oil in the emulsion was highly significant and contributed 4814.2 to the 4929.0 sum of squares attributable to the oil/water variance. Since there is no differences among the 5, 10, 20, and 40 percent oil concentrations it is possible that less than five percent oil would have resulted in activity equal to the five percent concentration. However, since it is unlikely that chaparral will ever be sprayed at gallonages in excess of 10 gallons per acre the question of how much less than five percent oil would suffice becomes of little practical importance.

There was no advantage gained by the addition of either surfactant to the spray mixture, at least not when any oil was present in the mixture. It is interesting to note that with no surfactant and no oil only 20 percent topkill was obtained. The addition of surfactant but no oil doubled this figure while the addition of oil to the mixture with or without surfactant essentially tripled it.

Table 7. Percent topkill of turbinella oak eight months following treatment with three pounds per acre of 2,4,5-T carried in various oil/water emulsion ratios with and without surfactants. Tempe, Arizona, 1959.

Percent topkill of turbinella oak						
	Percent oil in emulsion					
Surfactant	0	5	10	20	40	Mean
None	21	73	69	72	55	59
X-77	40	65	66	68	76	63
Plyac	39	67	82	82	74	69
Mean	33	69	72	74	69	

Experiment Number 3

Title.--Comparison of several formulations of 2,4,5-T and silvex for the control of turbinella oak.

Background.--Turbinella oak has not responded well to foliage applied herbicidal treatments. This is due to the sprouting ability of this species following topkill. As this sprouting appears to be restricted to stem tissue, particularly at the crown of the plant, the problem is one of obtaining a sufficient concentration of herbicide at the crown area to prevent sprouting.

Silvex and 2,4,5-T have resulted in more effective topkill of turbinella oak than has been evident with other herbicides applied at this station. Up to this time only standard low volatile ester, oil in water applications have been made. The purpose of this study is to compare these applications with the amine salts and Dow Chemical's "Forron" formulation. The Forron formulation is designed to give kill when applied in water equal to that obtained with oil/water emulsion of standard low volatile ester formulations.

Objective.--To compare oil in water low volatile ester formulations of 2,4,5-T and silvex with similar treatments using the amine salts and Forron formulations applied in water.

Methods and Materials.--Two and four pounds per acre of 2,4,5-T and silvex were applied May 20, 1959, as the low volatile ester, Forron, and amine salt formulations. The low volatile ester treatment was applied in a one to seven diesel oil in water emulsion. The amine and Forron formulations were applied in water. The plot size was 25 x 50 feet with a 10 foot isolation strip between plots. The experimental design was a randomized block with four replications.

The treatments were made from a 25-foot boom at 20 gallons per acre with a pressure of 30 pounds per square inch.

The weather at time of treatment was clear and sunny with a temperature of approximately 70°F and a wind velocity of roughly 10 miles per hour. The oak was apparently growing actively.

Results and Discussion.--Preliminary observations indicate that more topkill has resulted from the low volatile ester and Forron formulations than from the amine salt applications. The low volatile esters were slightly more effective than the Forron treatments. However, this is only preliminary observations at six months following treatment and reflects only leaf kill and defoliation. More realistic evaluation will be possible when observations are taken during the spring growing season.

Experiment Number 4

Title.--Effect on *Quercus turbinella* of various herbicides applied to the soil in granular or pelleted form.

Background.--Control of turbinella oak resulting from foliar herbicidal applications has been generally disappointing although some measure of topkill is possible with several herbicides. The ability of this species of oak to sprout following topkill by fire, chemicals, or other methods has made control quite difficult. This sprouting seems to be restricted to the crown, or that stem tissue at and below the soil surface. No instances of sprouts arising from root tissue have been observed. The sprouting ability of this plant must be impaired if control is to be effected.

Soil application of herbicides offers a possible means of getting the herbicide into the below ground portion of the plant where it must be if control of turbinella oak is to be realized.

For maximum effectiveness these soil applications should be made just prior to a rainfall. This would insure holding herbicide losses from volatilization and photoinactivation to a minimum. Also the herbicide must be leached into the root zone of the plant before it can be absorbed by the plant. Arizona climatic conditions are such that getting the herbicide on just prior to a rain cannot be accomplished with any degree of certainty. However, Arizona does have two expected rainy seasons, and this test was applied in December of 1958 and July of 1959 which is the first month of the expected winter and summer rainy seasons.

Objectives.--The objective of this study is to evaluate the use of granular and pelleted herbicides for control of turbinella oak. The experiment is designed to provide information on:

a. Relative activity of various herbicides.

b. Approximate effective application rate.

c. Susceptibility of chaparral species to soil application of herbicides.

d. Relative effectiveness of applications made prior to winter and summer rainy seasons.

e. Any interaction which may exist between herbicides and seasons.

Materials and Methods.--The following herbicides at four, eight, and 16 pounds per acre were applied on December 22 and 23, 1958.

Herbicide	Concentration
2,4,5-T LVE granular	12.7%
2,4-D LVE granular	12.8%
Silvex LVE granular	12.9%
Urox granular	22%
Monuron pelleted	25%
Fenuron pelleted	25%
TBA acid granular	25%
TBA amine granular	12.4%
Simazine granular	8.5%
Check	--

All formulations were obtained from commercial sources except the phenoxy compounds and the amine salt of TBA. These compounds were impregnated on 15/30 mesh attaclay (Fuller's earth) by addition

of the liquid formulations to the granular carrier. A known amount of attaclay was placed in a small cement mixer and the aliquot of herbicide added slowly while the mixer was in motion. The mixer was allowed to run until the attaclay appeared to be uniformly wetted. The concentration was calculated by weighing the impregnated attaclay after it had dried.

The herbicides were applied to 38 x 38 foot plots in three replications of a split plot experimental design. A 15 foot isolation strip was left between plots. The aliquot of herbicide was weighed into two equal portions. The plot was also divided into halves and each half applied separately.

Soil samples were taken in these plots in June of 1959 and again in September of 1959. The soil samples were taken with a Veighmeyer soil tube. Each plot was sampled at three locations chosen at random within the plot. The June 1959 samples were taken from the 0-4, 4-8, and 8-12 inch depth levels, while the September 1959 samples were taken in four inch segments to a depth of 16 inches. All three 0-4 inch depth level samples from a given plot were composited in a pint carton. This procedure was repeated for all depth levels sampled.

The sampling was accomplished by driving the tube to a depth of four inches, the tube was then pulled from the soil and the sample removed. The tube was then re-inserted in the hole and driven to a depth of eight inches, after which the sample was again removed. This procedure was repeated until the desired depth of sampling was attained. When the entire core was taken as a unit the soil was compressed so that a 12 inch sample might come out only eight inches long. It was not known then where to segment the core to get the soil representative of a given depth layer.

By going down four inches at a time a problem was sometimes encountered whereby the top layer was too dry and loose to be retained by the sampler. In this case the top layer of soil was sampled with a shovel and the tube used from there down. A slight amount of contamination was encountered when the sides of the hole would slough off as the tube was re-inserted into the hole. This soil was loose, however, and could be easily discarded from the more solid core extracted from the desired depth level.

The soil samples were allowed to air dry before being pulverized in a grinder and then planted with radish and oat seeds for the June sampling. The September sampling was planted with radish and ryegrass seeds. The seeded soil samples were placed in the greenhouse and allowed to grow for approximately four weeks prior to harvest.

Harvesting was accomplished by cutting the plants off at the soil level. Fresh weight of the harvested plants was recorded as data.

The July 1959 test was very similar to the December 1958 test. The major differences were:

a. 2,4,5-T was omitted.

b. 2,4-D and silvex application rates were increased to six, 12, and 24 pounds per acre. These were granular formulations obtained from commercial sources.

c. Simazine was omitted.

d. Urab was added at four, eight, and 16 pounds per acre.

e. Plot size was changed to 35 x 40.8 feet with 5 foot isolation strips between rates of chemicals and 15 foot strips between chemicals.

Soil samples were taken from this test at six inch intervals to a depth of 24 inches in the manner previously described.

An analysis of soil separates was made of a composite soil sample from the site where these tests are located. The 0-4, 4-8, and 8-12 inch depth layers were analysed by the hydrometer method. Gravel was seived out prior to analysis. The gravel percentages were: 0-4, 25 percent; 4-8, 25.9 percent; and 8-12, 21.7 percent. The separate analysis for sand, silt, and clay are given in Table 8.

Table 8.--Separate analysis (excluding gravel) of soil from soil herbicide test at the 0-4, 4-8, and 8-12 inch depth layers. Tempe, Arizona, 1959.

Depth of Sampling	Percent sand	Percent silt	Percent clay
0-4 inches	30.9	56.0	13.1
4-8 inches	41.6	38.2	20.2
8-12 inches	45.6	29.2	25.2

Results and Discussion.--The 1958 test has been evaluated two times, on July 24, 1959, and December 2, 1959. These evaluations are in percent apparent topkill. If a plot was 100 percent defoliated or all leaves were dead the plot would be given an evaluation of 100.

It would be possible that the shrubs were merely defoliated and no actual kill had been obtained. These figures do not reflect kill, or even topkill, but only apparent topkill at the time the evaluation was made. These figures reflect only effect on turbinella oak. Other chaparral species are present in the plots, but not with sufficient consistency or density to enable the collection of reliable data.

The data (Tables 9, 10 and Appendix Table 4) incidate that soil treatments with the benzoic acid compounds and the substituted ureas are far more active on turbinella oak than soil treatments with the phenoxy compounds. The oak reacts to the substituted ureas, and fenuron in particular, by developing the marginal necrosis on the leaves that is typical of the substituted ureas. The leaves eventually fall, leaving the plant entirely defoliated and apparently dead. However, when this occurs during the growing deason the plants refoliate clear to the tips of the live branches (Figure 4). While taking the June 1959 evaluation it was observed that several of the shrubs in the plots treated with 16 pounds of fenuron were the greenest and healthiest looking bushes in the entire test. This defoliation-refoliation was less evident with monuron (Figure 4) and not in evidence with urox (Figure 4). When the evaluation was made in December the cold temperatures prevented refoliation and excellent apparent control was exhibited by fenuron and monuron. Just how often the plant will be able to withstand this defoliation is not known. There is a limited amount of fenuron in the soil, and this is constantly being broken down by micro-organisms. It would seem that

control with fenuron will depend on the persistence of the chemical in relation to the ability of the plant to repeatedly refoliate.

It is obvious that a certain amount of fenuron must be contained in the fallen leaves. Whether or not this fenuron is ever released to the soil in a phytotoxic form is not known. Experiments are contemplated which may provide this information.

The two benzoic acid formulations have resulted in fairly effective apparent kill of oak in each of the two evaluations. Unlike the substituted urea compounds these herbicides are powerful inhibitors of growth on turbinella oak. The defoliation is not as rapid as with the ureas, nor is it nearly so complete, however, the very small amount of regrowth that has been observed has been badly malformed and much of this regrowth has died (Figure 4). The plants are still alive, however, and as with the urea herbicides, control will hinge on the ability of the herbicide to persist long enough to kill the plant.

The phenoxy compounds and simazine have not shown sufficient activity as soil applied herbicides to warrent further testing.

The bio-assays of the soil samples (Figures 5, 6, 7 and Appendix Table 5) give some indication of the persistence and leachability of the various herbicides applied in this experiment. Perhaps the most surprising fact yielded by these bio-assays is the absence of the benzoic acid compounds at those depth layers in the soil which were sampled. It seems unlikely that slightly over five inches of rainfall (Table 11) would have leached the herbicide below the eight inch

soil level. However, in view of the inhibitory effect on the growth of oak which persisted at least until December of 1959 it is even more unlikely that the herbicide was dissipated from the soil in June. It is possible that the herbicide may be leached or dissipated from the soil but retained in the plant.

The persistence and insolubility of monuron is demonstrated by the bio-assay with the largest concentration of monuron and urox remaining in the 0-4 inch level even nine months following application. By this time the fenuron was beginning to dissipate from decomposition and leaching.

Laboratory leaching studies will be initiated soon which, it is hoped, will provide information as to the relative importance of leaching and decomposition on the dissipation of these herbicides in Arizona chaparral soils.

The second (July 1959) application of granular or pelleted herbicides has been evaluated only once. The results (Table 12 and Appendix Table 6) are much the same as with the earlier test. Since the temperature was too low to permit regrowth after defoliation the substituted urea treated oak looks to be completely killed (Figure 8). How these plants will react in the spring is not known.

While it is not possible to collect reliable data on the reaction of other species to these herbicides, some observations have been made which are consistent enough to warrent comment.

Among these is the apparent susceptibility of squawberry (Rhus trilobata) to TBA amine. While it is possible that this species may

sprout in the spring, at the end of the last growing season most of the squawberry occurring in the TBA amine plots was at least top-killed. Not all of the grass (mainly *Bouteloua gracilis* and Muhlenburgia sp.) on the TBA plots has been killed at this time.

In contrast the grasses on the fenuron plots have been completely killed at the eight and 16 pound rates and about 75 percent killed at the four pound rate. Snakeweed (*Gutierrezia sarothroe*) has been completely killed by fenuron, in fact it is possible to exactly identify the outlines of the fenuron plots by the dead snakeweed. Most other chaparral species present, and this includes some very desirable species such as mountain mahogany (*Cercocarpus montanus*), Ceanothus (*Ceanothus greggii*), and cliff rose (*Cowania* mexicana, have been injured at least as severly as turbinella oak. It seems safe to predict that any rate of fenuron which will kill turbinella oak will kill all other species on the site as well.

Table 9.--Percent apparent kill of turbinella oak six and 12 months after treatment with various granular or pelleted herbicides in December of 1958. Tempe, Arizona, 1959.

		Evaluated 6/24/59		Evaluated 12/3/59	
Treatment	Lbs/Acre	Percent apparent kill	Treatment mean	Percent apparent kill	Treatment mean
	-	1		-	
Check	-	2	2	-	-
	-	1		-	
	4	2		0	
Simazine	8	2	3	0	0
	12*	5		0	
	4	1		0	
2,4,5-T	8	4	3	0	1
	12	5		2	
	4	3		0	
Silvex	8	3	4	0	0
	12	6		0	
	4	3		0	
2,4-D	8	4	6	0	2
	12	13		5	
	4	13		30	
Monuron	8	43	32	75	66
	12	51		94	
	4	57		83	
Fenuron	8	30	41	93	92
	12	75		99	
	4	29		50	
TBA acid	8	57	46	70	67
	12	57		78	
	4	17		17	
Urox	8	57	50	14	42
	12	79		68	
	4	55		48	
TBA amine	8	54	55	65	64
	12	54		78	

* All 12 lbs/acre rates miss-labled, 16 is correct.

Table 10.--Duncan multiple range test at five percent probability level on treatment means of apparent kill of turbinella oak six and 12 months following treatment in December of 1958 with various granular or pelleted herbicides. Analysis of variance (Appendix Table 4) and Duncan test performed on transformed data, but presented on untransformed data. Tempe, Arizona, 1959.

	Evaluated 6/24/59									
Treatment	Check	Simazine	2,4,5-T	Silvex	2,4-D	Monuron	Fenuron	TBA acid	Urox	TBA amine
Treatment mean*	2	3	3	4	6	32	41	46	50	55

	Evaluated 12/3/59									
Treatment	-	Simazine	Silvex	2,4,5-T	2,4-D	Urox	TBA amine	TBA acid	Monuron	Fenuron
Treatment mean*	-	0	0	1	2	42	64	67	66	92

* All means not underlined by the same line are significantly different.

Table 11. Rainfall recorded approximately one half mile from soil herbicide plots. Figures shown represent accumulation of rainfall since previous date of recording Tonto Flats, Arizona, 1959.

Date Recorded	Rainfall accumulation, inches
2/19/59	3.89
2/26/59	0.67
4/8/59	0.00
4/16/59	0.11
5/5/59	0.48
5/9/59	0.00
6/17/59	0.16
6/24/59	0.08
7/9/59	0.00
7/13/59	0.00
7/17/59	0.00
7/23/59	1.21
8/11/59	2.23
8/16/59	0.32
8/28/59	2.65
9/11/59	0.12
9/16/59	0.10
9/28/59	0.00
10/20/59	0.00

Table 12.--Percent apparent kill of turbinella oak approximately six months after treatment with various granular or pelleted herbicides in June of 1959. Tempe, Arizona, 1959.

Treatment	Check	Silvex	2,4-D	TBA amine	TBA acid	Monuron	Urox	Urab	Fenuron
Pounds per acre	0 0 0	6 12 24	6 12 24	4 8 16	4 8 16	4 8 16	4 8 16	4 8 16	4 8 16
Percent apparent kill	0 2 0	2 5 15	4 17 30	17 45 60	45 53 78	38 82 85	41 66 96	40 72 97	88 96 98
Treatment mean*	1	7	17	44	59	68	68	70	94

* All means not underlined by same line are significantly different at the five percent probability level. This multiple range test was performed on arcsin transformed data, but is presented on untransformed data.

Figure 4.--Control of turbinella oak six months following a December 1958 application of eight pounds per acre of various granular or pelleted herbicides. Herbicidal treatments as labelled in pictures, picture at upper left is a check plot.

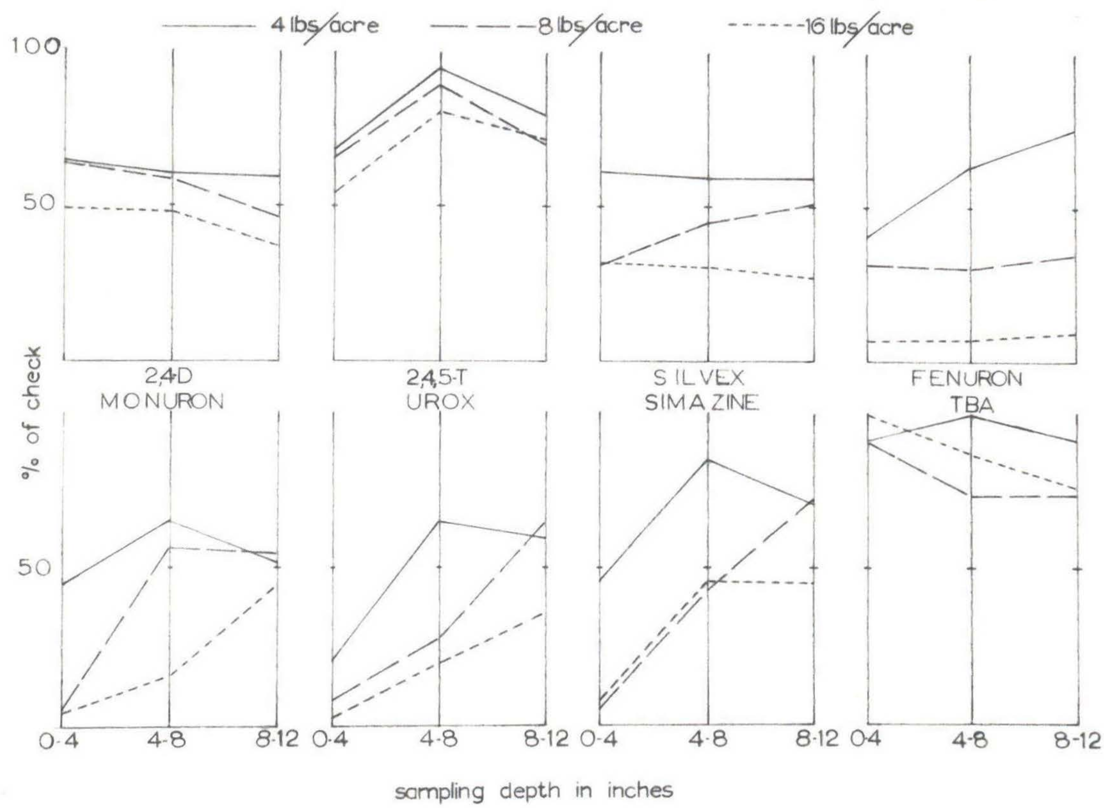

Figure 5.--Results of bio-assay of soil samples taken from plots six months after a December 1958 treatment of the plots with various granular or pelleted herbicides.

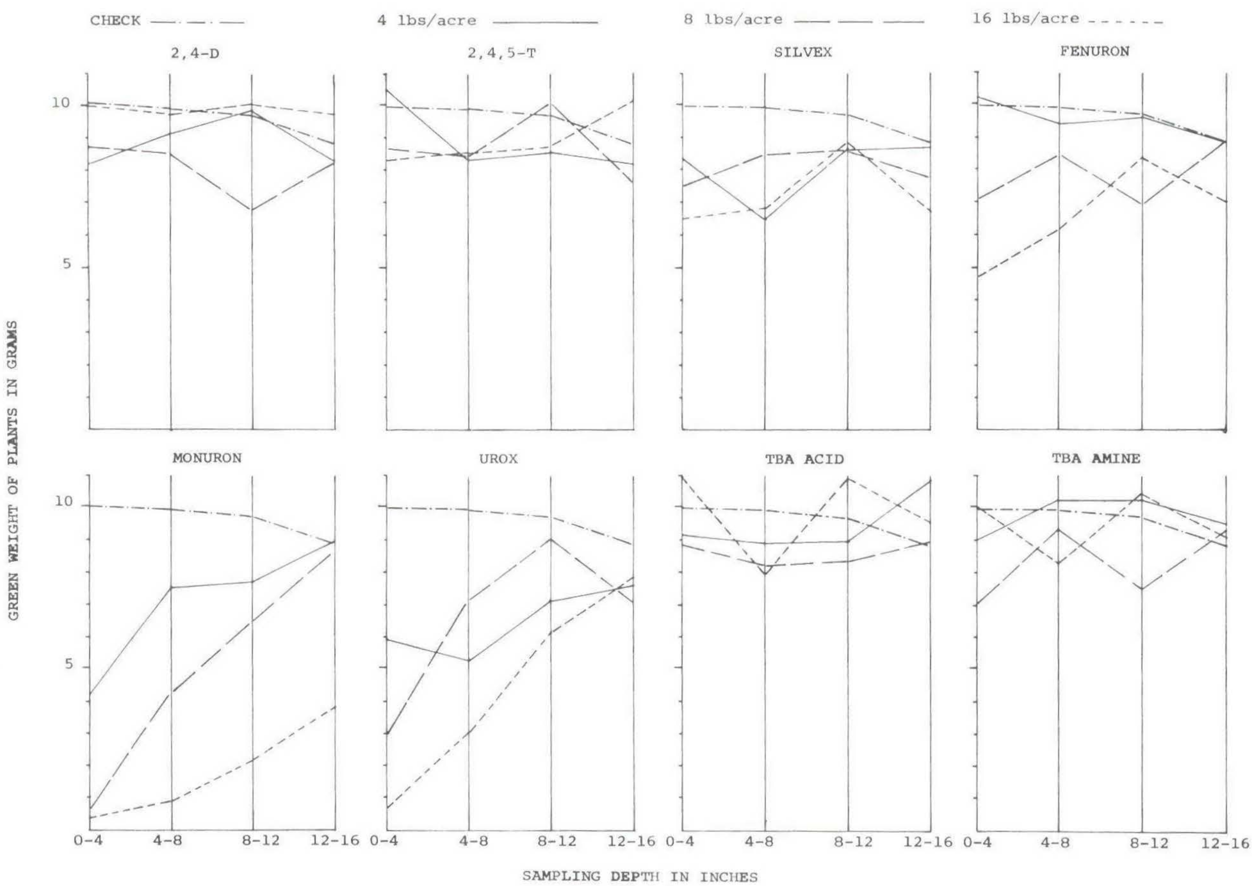

Figure 6.--Results of bio-assay of soil samples taken from plots nine months after a December 1958 treatment of the plots with various granular or pelleted herbicides.

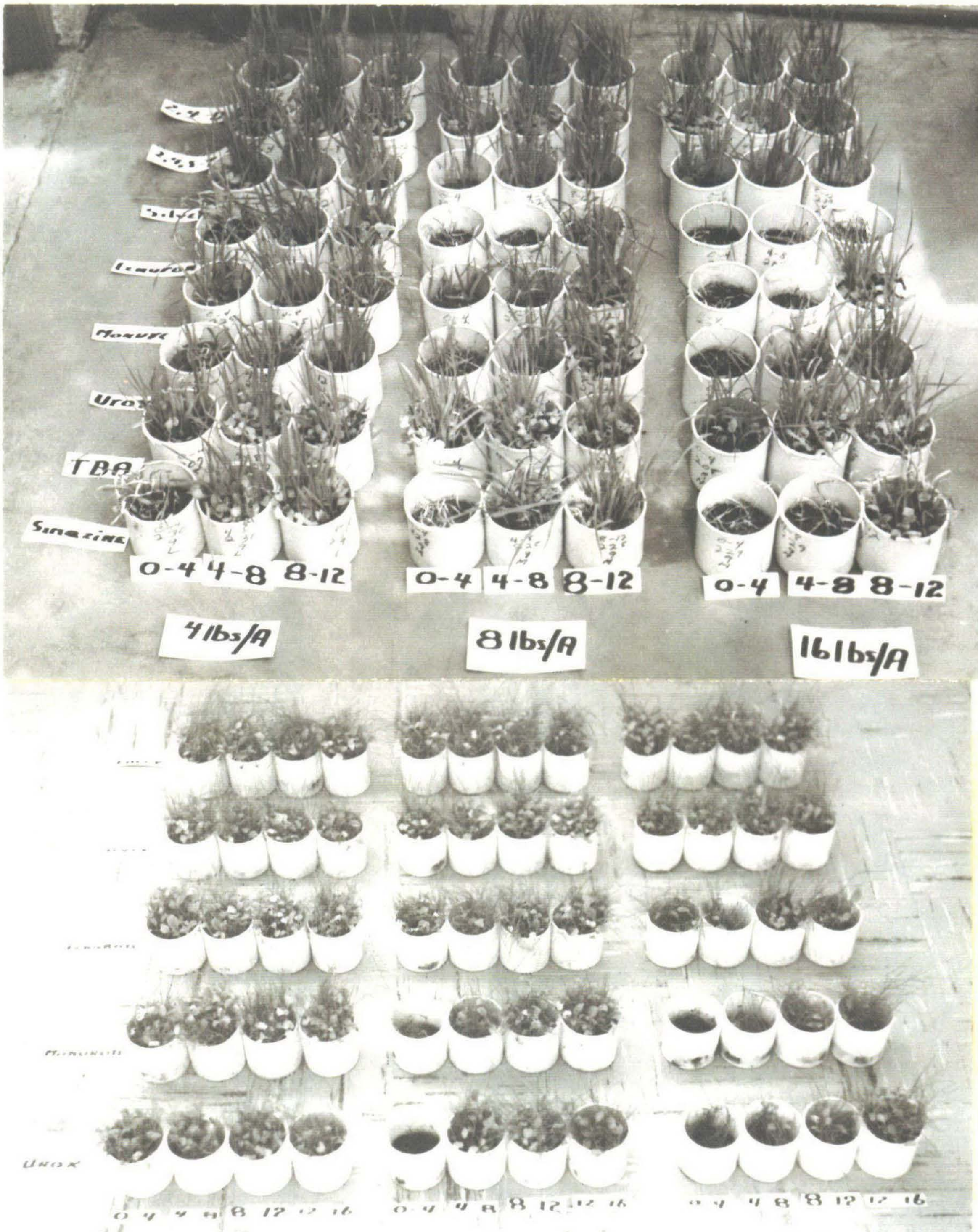

Figure 7.--Bio-assay of soil samples taken from plots six (upper photo) and nine (lower photo) after treatment of the plots with various granular or pelleted herbicides.

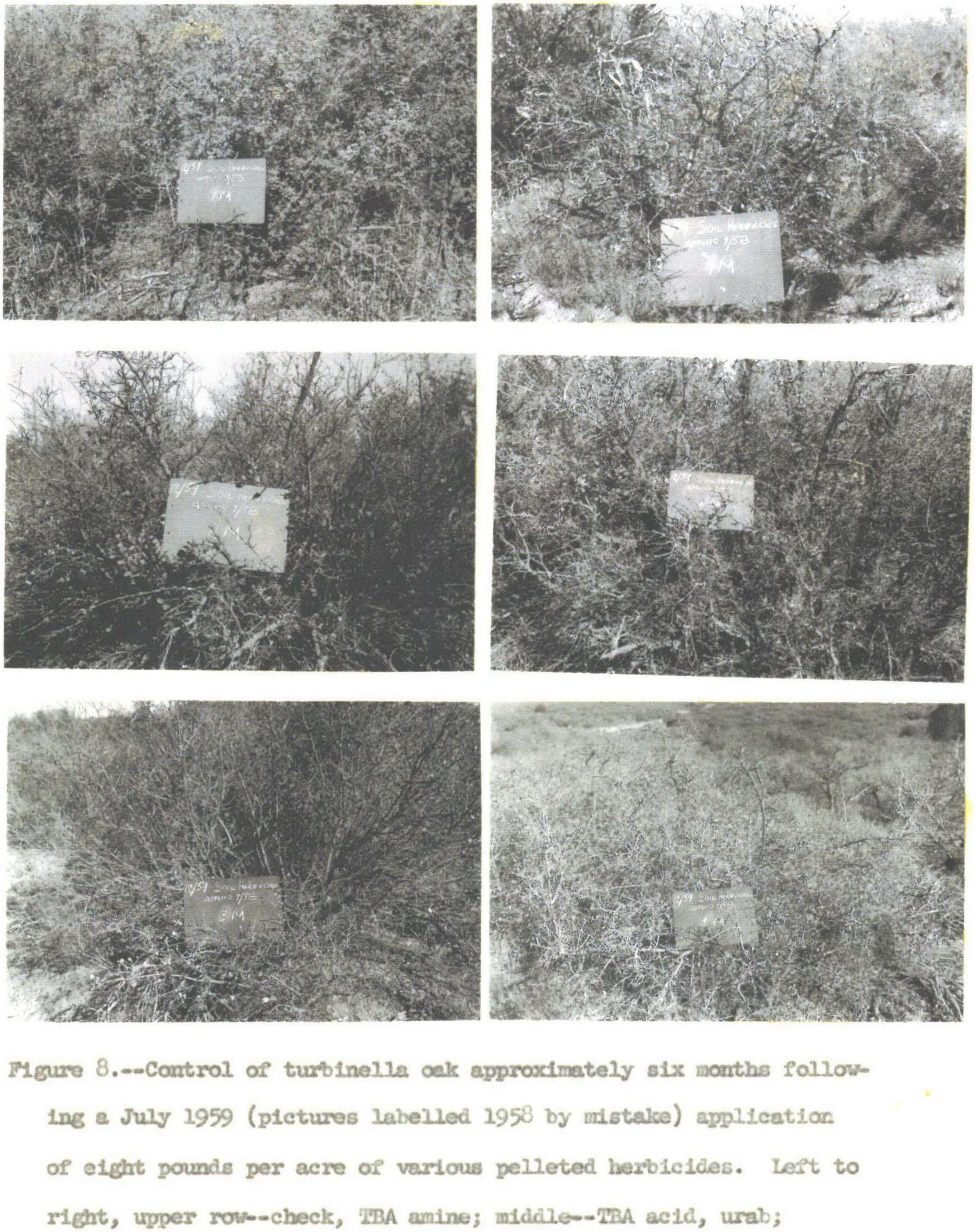

Figure 8.--Control of turbinella oak approximately six months following a July 1959 (pictures labelled 1958 by mistake) application of eight pounds per acre of various pelleted herbicides. Left to right, upper row--check, TBA amine; middle--TBA acid, urab; lower--monuron, fenuron.

Experiment Number 5

Title.--Chemical dessication of turbinella oak.

Background.--Prescribed burning alone or followed by chemical treatment may prove to be a valuable tool for the control of Arizona chaparral species. Prescribed burning followed by reseeding to perennial grasses has already been shown to be an acceptable practice for the improvement of chaparral rangeland.

Controlled or prescribed burning in Arizona is either a difficult or hazardous operation depending upon the weather conditions at the time of burning. Under conditions of low relative humidity, low fuel moisture, and high temperature, the chaparral will usually burn readily, but the danger of wildfire is great. The costs of running fire lanes and guarding the fire under these conditions are prohibitive. When the conditions are less flammable the chaparral will burn only with great difficulty.

Through chemical dessication in restricted areas it may be possible that the pretreated areas will burn readily when the danger or wildfire is greatly reduced. It might also be possible to pretreat and burn wide fire lanes when danger of wildfire is low, and then burn the major area untreated when natural conditions were such that a fire would carry readily. Still a third possibility is that the pretreatment might inhibit sprouting of the oak following the fire.

Objectives.--The objective of this study is to evaluate the effect of foliage applied dessicants or herbicides on the fuel moisture content of turbinella oak. The experiment is designed to provide

preliminary information on:

a. The effectiveness of various dessicants or herbicides in reducing the fuel moisture content of turbinella oak.

b. Approximate effective application rates.

c. Length of time required for maximum expression of chemical activity.

d. The effect of season of application upon the rate and extent of dessication of turbinella oak.

<u>Materials and Methods</u>.--The following dessicants or herbicides were applied at the indicated application rates.

Chemical	Pounds per acre
Check	0 and 0
Silvex in oil	2 and 4
2,4-D in oil	2 and 4
DNBP in oil	2 and 4
Chlorate-borate in water	20 and 40
FB-2 in water	2 and 4

These materials were applied March 26, 1959, to single bush plots at 20 gallons per acre. Oil used as a carrier was diesel oil and two milliliters per gallon of Colloidal "X-77" wetting agent was added to both oil and water carried applications. There were four replications of a randomized block experimental design.

The treatments were applied at a pressure of 30 pounds per square inch from a six foot hand boom fitted to a $2\frac{1}{2}$ gallon hand sprayer (Figure 9).

Fuel moisture samples were taken of leaves and small twigs seven, 21, and 42 days after treatment. Additional fuel moisture samples of small twigs only were taken 110 days after treatment.

Samples were taken by stripping off leaves on the north, south, east, and west sides of the bush. The leaves were placed into small bottles which were capped immediately. The twigs sampled were those from which the leaves were stripped in taking the leaf samples. The twigs were likewise placed into small bottles and the bottles capped immediately. The samples were dried at 110°C for 24 hours and the moisture loss calculated as percent of dry weight.

Results and Discussion.--The results of the seven, 21, and 42 day samplings are shown in figure 10. The 110 day sampling of twigs is shown in table 13 and Appendix table 7.

All chemicals, with the exception of FB·2, were effective in reducing the fuel moisture content of turbinella oak leaves. The chlorate-borate and DNBP treatments resulted in the most rapid dessication, however, 21 days after application there was considerable leaf drop with the higher rates and after 42 days the high rate of DNBP and both rates of the chlorate-borate treated bushes were refoliated with succulent new leaves. It would appear that these treatments are not desirable ones from the standpoint of lowering the fuel moisture content of turbinella oak. There is some question as to whether it is more desirable, from the standpoint of flammability of the matrix, to have the dead leaves adhere to the twigs or fall to the ground. The assumption is that the leaves adhering to the

small twigs would tend to concentrate what heat is available around the more easily ignited plant parts, although this has not been tested.

The two phenoxy compounds, and 2,4-D in particular, were quite effective in dessicating the oak leaves. It is interesting to note that the light rates of both phenoxy compounds were faster in action than the higher rates, although at the 42 day sampling time there was no difference between the two rates.

When moisture samples of small twigs were taken seven, 21, and 42 days after treatment none of the chemicals had lowered the fuel moisture below that of the check. At 110 days, however, silvex, 2,4-D, and DNBP had all lowered the fuel moisture below the check. 2,4-D and silvex were significantly more effective than DNBP at this time.

It would seem that 2,4-D, mainly because of its relative cost, may have some possibilities as a dessicant for treatment of turbinella oak prior to burning.

On the results of this initial experiment this study is to be re-evaluated before continuing on to the other seasons of application. It is proposed to drop the chlorate-borate, FB-2, and DNBP treatments, and add 2,4,5-T and an oil check. It is hoped that the study can also be expanded to include an actual burn after treatment, although the USFS is understandably cautious about entering into this phase of the study.

Table 13.--Fuel moisture, on a percent of dry weight basis, of small twigs (up to 0.25 inches in diameter) 110 days after treatment with various herbicides or dessicants. Tempe, Arizona, 1959.

Treatment	Silvex		2,4-D		DNBP		$NaClO_3$		FB-2		Check	
lbs/Acre	2	4	2	4	4	8	20	40	2	4	-	-
Percent fuel moisture	34.7	29.0	35.7	27.0	45.7	41.5	51.2	44.5	52.2	50.2	53.0	53.5
Treatment mean*	31.9		31.4		43.6		47.9		51.2		53.2	

* All means not underlined by the same line are significantly different at the one percent probability level.

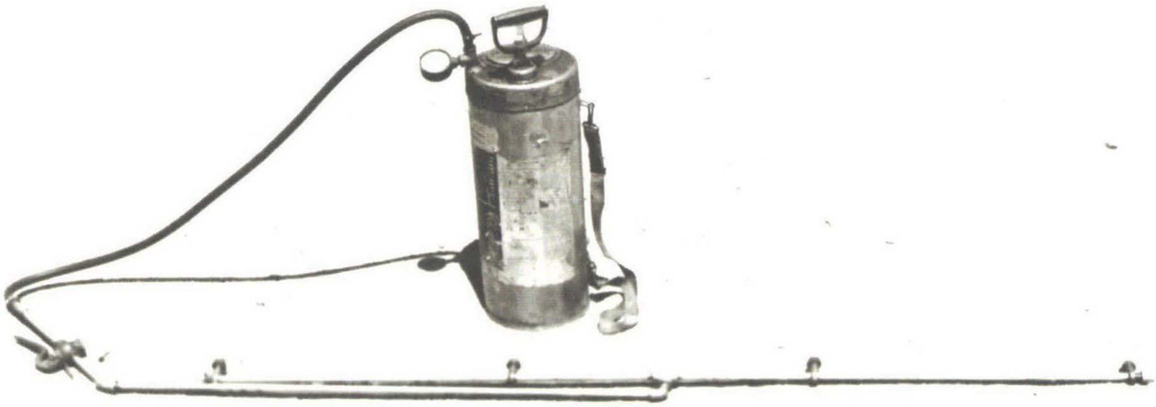

Figure 9.--Sprayer used making herbicidal applications.

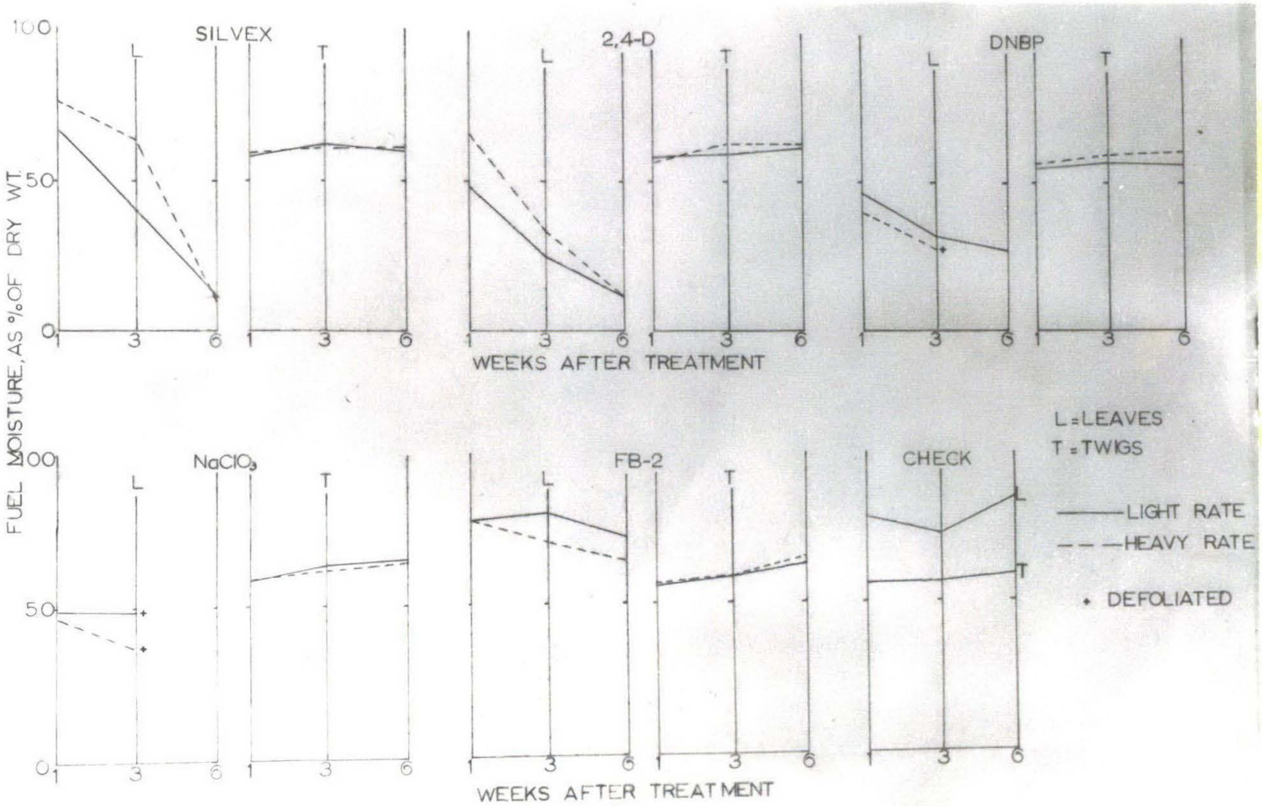

Figure 10.--Fuel moisture of turbinella oak leaves and small twigs, on a percent of dry weight basis, seven, 21, and 42 days after treatment with various herbicides or dessicants. Tempe, Arizona, 1959.

Experiment Number 6

Title.--Influence of application date upon control of turbinella oak with low volatile esters of 2,4,5-T and silvex.

Background.--Foliar application of herbicides has not resulted in adequate control of turbinella oak. Varying amounts of topkill have been obtained, but sprouting has always occurred from the crown portion of the plant.

If control of this species is to be effected with foliar applications, some weak spot in the sprouting armor of this plant must be found. This could be a period of maximum susceptibility to herbicides or a period of maximum translocatability of the herbicide, thereby getting the herbicide into the crown portion of the plant in sufficient concentration to inhibit sprouting.

Many investigators, working with other species have reported that spring application of herbicides result in a higher degree of control than do similar applications at other times of the year. In view of these findings, spring seems the most logical time to explore for susceptibility unless other experiments provide information indicating that oak may be more susceptible at other times of the year.

Objectives.--The objective of this experiment is to explore the spring growing season for a period in which turbinella oak is susceptible to foliar application of herbicides. A second objective is to compare 2,4,5-T and silvex (PGBE esters) under these conditions.

Materials and Methods.--Two, four, and eight pounds per acre of 2,4,5-T and silvex were applied at various dates in the spring of the year. They were applied to single bush (or clump) plots (five replications of a randomized block) at a volume of 20 gallons per acre. The herbicides were emulsified in pure water and two milliliters per gallon of Colloidal Chemical's "X-77" surfactant were added.

Following are the dates of treatment with the climatological estimates and phenological observations made at time of treatment.

Date of treatment - 3/12/59

a. Temperature mild, 60-70°F, gentle breeze.

b. No activity apparent in *Rhus trilobata* or *Mimosa biuncifera* both of which are deciduous species.

Date of treatment - 4/2/59

a. Temperature mild, 65-70°F; wind, 10 m.p.h.

b. *Rhus* flowering with about ½ of the blossoms fully opened, just beginning to show a few leaves on scattered plants. Manzanita (*Arctostaphylos pungens*) in full bloom. No activity in *Mimosa*.

Date of treatment - 4/10/59

a. Clear and sunny, temperature 70°F; intermittent winds up to 15-20 m.p.h.

b. Most *Rhus* about ½ leafed out. Manzanita still in bloom. No activity in *Mimosa*.

Date of treatment - 4/21/59

a. Clear and sunny, temperature 75°F; wind 10 m.p.h.

b. *Rhus* fully leafed out on most shrubs, some still about

$\frac{1}{2}$ leafed. No observed activity in _Mimosa_. Oak has not yet started to grow.

Date of treatment - 4/24/59

a. Clear and sunny, temperature 75°F; wind gusty, up to 15-20 m.p.h.

b. _Rhus_ fully leafed on all but a few shrubs. _Mimosa_ now starting to leaf out. An occasional oak plant showing growth activity.

Date of treatment - 5/1/59

a. Cloudy, temperature 70°F; windy, about 18-20 m.p.h.

b. An occasional _Rhus_ still not fully leafed. _Mimosa_ fully leafed on many plants. Oak buds starting to burst.

Date of treatment - 5/8/59

a. Clear and sunny, temperature 75-80°F; wind 8-10 m.p.h.

b. Oak growing actively.

Date of treatment - 5/29/59

a. Clear and sunny, temperature 75°F; wind 10-15 m.p.h.

b. Oak still seems to be growing actively although vegetation in general showing signs of moisture stress. Squawberries (_Rhus_ fruit) turned red.

Estimates of apparent topkill were made on June 30, 1959, and January 1, 1960. It should again be emphasized that these figures reflect nothing but percent apparent topkill. No actual kill was observed. Figure 11 illustrates the condition of the bushes assigned the shown percent apparent topkill.

Results and Discussion.--The results of this preliminary test (Tables 14, 15 and Appendix Table 8) do not give any sign of a period in the spring when turbinella oak might be most susceptible to foliar sprays with the herbicides used. There was no detectable difference between dates of treatment. Admittedly the method of taking data was not sufficiently precise to detect small differences. However, the difference between 25 and 35 percent topkill is of no great importance, particularly in view of the probability that this difference will vanish with the spring growing season.

The condition of the oak plants in the spring of 1959 was not one that is commonly associated with optimum susceptibility to herbicides. An early and severe frost in November of 1958 had frozen the leaves of the oak. This was followed by an abnormally dry winter so that the flush of growth by oak in the spring was a short one. This was followed by partial defoliation of the oak due to the severe moisture deficit. This defoliation was estimated to be from 40 to 60 percent at the experimental location.

The spring of 1960 is destined to be a good one for the growth of vegetation. Arizona received good late summer rainfall in 1959; this has been followed, to date, with excellent winter rainfall. It is estimated that the entire soil mantle is charged with water at this time and it is still raining. Therefore, the spring of 1960 should be an ideal time to repeat this experiment.

Silvex was found to be significantly more effective than 2,4,5-T at the time the January 1960 observations were made. When the June 1958 observations were taken, 2,4,5-T tended to be slightly more effective than silvex, although statistical comparisons were not made. This set of circumstances has been observed before. 2,4,5-T seems to be about as effective as silvex and a little quicker in producing topkill, whereas silvex seems to be somewhat more effective in preventing regrowth. The sprouting potential of turbinella oak, however, is generally sufficient to mask any differences that may exist by the end of the spring growing season.

When the application rates were compared using a Duncan multiple range test, it was found that all three application rates were better than the check. Eight pounds of 2,4,5-T or silvex was more effective than two, while four pounds per acre did not differ significantly from either two or eight pounds per acre.

Table 14.--Percent apparent kill of turbinella oak on 1/8/60 after treatment at various times with two, four, and eight pounds per acre of 2,4,5-T and silvex. Tempe, Arizona, 1959.

	Applied 3/12/59								Applied 4/2/59							
	2,4,5-T				Silvex				2,4,5-T				Silvex			
Lbs/Acre	0	2	4	8	0	2	4	8	0	2	4	8	0	2	4	8
Percent apparent kill	4	33	34	57	3	36	53	68	4	49	46	39	4	36	29	49
Treatment mean	32 (41.3) less check (0)				40 (52)				35 (45)				29 (38)			
Application date mean	36								32							

	Applied 4/10/59								Applied 4/17/59							
	2,4,5-T				Silvex				2,4,5-T				Silvex			
Lbs/Acre	0	2	4	8	0	2	4	8	0	2	4	8	0	2	4	8
Percent apparent kill	3	32	38	56	5	43	31	64	4	25	30	45	3	30	40	67
Treatment mean	32 (42)				36 (46)				26 (33)				35 (46)			
Application date mean	34								30							

	Applied 4/24/59								Applied 5/1/59							
	2,4,5-T				Silvex				2,4,5-T				Silvex			
Lbs/Acre	0	2	4	8	0	2	4	8	0	2	4	8	0	2	4	8
Percent apparent kill	3	14	39	50	3	25	49	53	5	15	30	36	4	18	36	56
Treatment mean	26 (34)				32 (42)				21 (27)				28 (37)			
Application date mean	29								25							

	Applied 5/8/59								Applied 5/29/59							
	2,4,5-T				Silvex				2,4,5-T				Silvex			
Lbs/Acre	0	2	4	8	0	2	4	8	0	2	4	8	0	2	4	8
Percent apparent kill	8	24	45	49	10	21	49	50	3	26	24	43	8	26	36	56
Treatment mean	32 (39)				33 (40)				24 (31)				31 (39)			
Application date mean	32								28							

Table 15.--Percent apparent kill of turbinella oak on 6/30/59 after treatment at various times with two, four, or eight pounds per acre of 2,4,5-T and silvex. Tempe, Arizona, 1959.

	Applied 3/12/59						Applied 4/2/59					
	2,4,5-T			Silvex			2,4,5-T			Silvex		
Lbs/Acre	2	4	8	2	4	8	2	4	8	2	4	8
Percent apparent kill	77	88	94	55	87	96	93	93	97	91	87	97
Treatment mean		84			79			94			91	
Application date mean			82						93			

	Applied 4/10/59						Applied 4/17/59					
	2,4,5-T			Silvex			2,4,5-T			Silvex		
Lbs/Acre	2	4	8	2	4	8	2	4	8	2	4	8
Percent apparent kill	95	88	96	87	89	94	96	97	96	91	91	97
Treatment mean		93			90			96			93	
Application date mean			91						95			

	Applied 4/24/59						Applied 5/1/59					
	2,4,5-T			Silvex			2,4,5-T			Silvex		
Lbs/Acre	2	4	8	2	4	8	2	4	8	2	4	8
Percent apparent kill	77	85	96	65	93	96	78	93	94	53	83	97
Treatment mean		86			85			88			78	
Application date mean			85						83			

	Applied 5/8/59						Applied 5/29/59					
	2,4,5-T			Silvex			2,4,5-T			Silvex		
Lbs/Acre	2	4	8	2	4	8	2	4	8	2	4	8
Percent apparent kill	91	94	98	81	94	91	96	84	95	91	94	96
Treatment mean		94			89			92			93	
Application date mean			91						92			

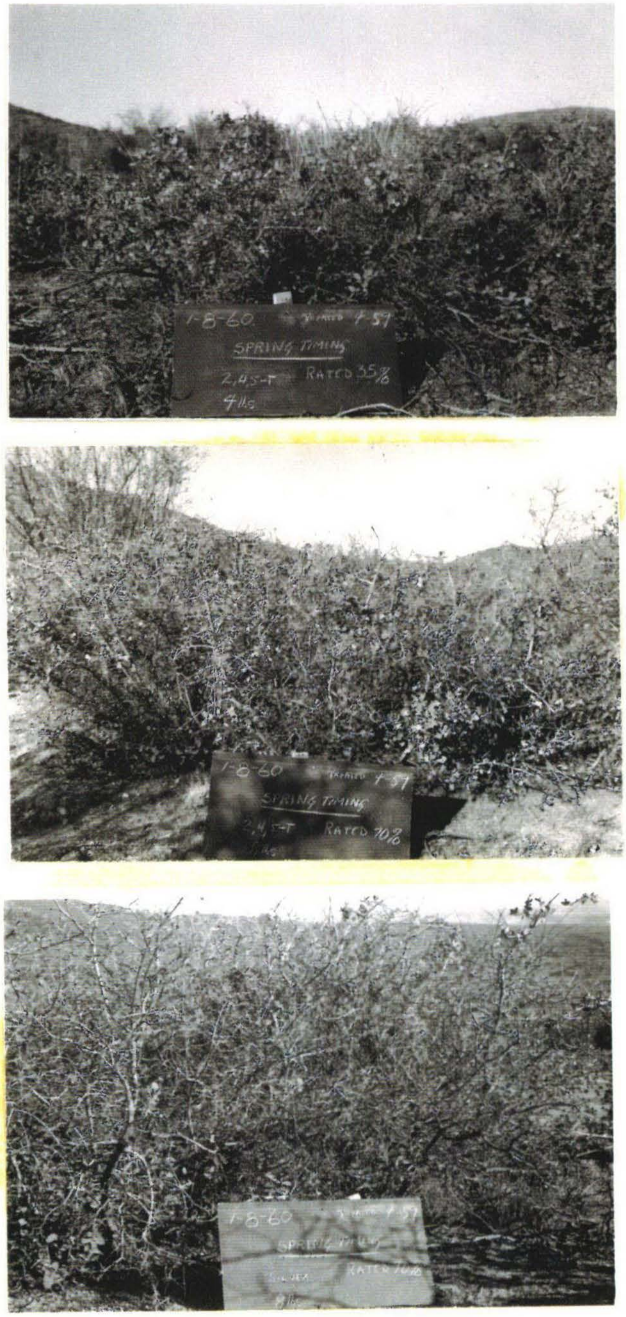

Figure 11.--Photographs taken 1/8/60 of bushes treated 4/2/58 with indicated rates and herbicides. Bushes to be photographed were picked at random, after evaluation was completed, to show examples of bushes rated from 35 to 90 percent topkill.

Experiment Number 7

Title.--Number of reapplications of 2,4,5-T or TBA amine necessary to control fire sprouts of Quercus turbinella.

Background.--Single or two annual applications of phenoxy herbicides have not been sufficient to control turbinella oak. However, topkill can be obtained with a single application. If the plant is topkilled frequently enough over a long enough period of time, the result must eventually be the death of the plant even without systemic herbicidal action. It seems to be of at least academic interest to determine just how many retreatments will be required for complete control of this species.

Trichlorobenzoic acid derivatives have not resulted in rapid topkill of turbinella oak as have the phenoxy derivatives. On the other hand the benzoic acid compounds have been very effective in suppressing the growth of the oak. Complete recovery has been observed one year following treatment of fire sprouts of turbinella oak with 2,4,5-T or silvex, whereas similar benzoic acid treated plots were still suppressed in growth and any new growth was badly malformed and often dead or dying. It is also of interest to determine the effect on turbinella oak of repeated treatments with benzoic acid compounds.

Objectives.--To determine how long annual or semi-annual retreatments of turbinella oak with TBA amine or 2,4,5-T (PGBE) must be continued to effect kill of turbinella oak. A second objective is to compare 2,4,5-T and TBA amine for relative effectiveness as to number of retreatments required.

Materials and Methods.--The treatments consisted of a two pound per acre rate of 2,4,5-T and TBA applied in the spring, in the fall, and both spring and fall until such time as control of turbinella oak has been accomplished. The first spring treatment was applied 5/8/59 and the first fall treatment was applied 9/24/59.

These applications were made from a 25 foot boom mounted on an Oliver OC-4 crawler tractor. The pressure was 30 pounds per square inch and the treatments were carried by water at a gallonage of 20 gallons per acre.

The plots are 25 x 50 feet and arranged in six replications of a randomized block experimental design. The plot area had been burned off and reseeded to Lehmann's lovegrass (Eragrostis lehmanniana) in June of 1958.

Prior to treatment a single clump of oak was staked in each plot and the total number of sprouts in that clump was recorded along with the average height of the five tallest sprouts. It was proposed to recount these clumps prior to each treatment. Since not all the plots had been retreated at the time of the second treatment the counts were not taken. The area was so overgrown with lovegrass that the counts would have been nearly impossible to make in any case.

An estimate of percent apparent topkill was made on December 2, 1959.

Results and Discussion.--Since this is a retreatment test and only one third of the plots have been retreated it is too soon to present much in the way of results. The evaluation (Table 16) reflects the rapid and extensive topkill of turbinella oak obtained with 2,4,5-T. The different effects of 2,4,5-T and TBA are also apparent.

The plots treated with 2,4,5-T in the spring, which had undoubtedly attained an apparent topkill of over 80 percent shortly after treatment, have recovered to where only 30 percent apparent topkill is evident. The spring treated TBA plots were rated at 15 percent topkill which is probably the highest they had attained up to that point.

The growth of the TBA treated plots was almost totally suppressed with the small amount of regrowth present showing marked formative effects. The regrowth of the 2,4,5-T treated plots was apparently normal.

The lovegrass had not been noticeably affected by either treatment. There has been some formative effects on lovegrass in TBA treated plots in other tests. The lovegrass will be watched closely in the spring for effects from repeated TBA applications.

The checks in this test had some herbicide effect from drift. Due to this effect only the spring-fall treatment with TBA differed significantly from the checks (Table 16, and Appendix Table 9). All 2,4,5-T treatments differed significantly from the checks.

Table 16.--Percent apparent kill of turbinella oak on December 2, 1959 after treatment in the spring, fall, or spring and fall with two pounds per acre of 2,4,5-T or TBA. Tempe, Arizona, 1959.

Treatment	Check	TBA			2,4,5-T		
Time of Treatment	-	Fall	Spring	S-F	Spring	Fall	S-F
Percent apparent kill*	7	8	15	26	30	83	87

* All means not underlined by same line differ at the five percent probability level.

Experiment Number 8

Title.--The effectiveness of pellet and granular applications of several herbicides, as influenced by leaching, on the control of turbinella oak.

Technical Personnel.--E. A. Davis, Plant Physiologist
D. T. Lillie, Research Agronomist

Background.--Foliar sprays with ground or aerial equipment have not been satisfactory for the control of turbinella oak due to the fact that they have not prevented sprouting. Soil applications of pelleted or granular forms of herbicides may be more effective in preventing sprouting as well as promoting topkill of turbinella oak.

One of the major considerations concerning soil application of herbicides is the leaching of these applications into the root zone of the plant. The occurrence of rainfall under Arizona climatological conditions is at best a probability that rain will occur in the winter and summer. Either one or both of these rainy seasons may yield relatively little precipitation in a given year. Therefore, it is desirable to know the amount of water necessary to leach the herbicide into the root zone and promote chemical control of the brush. Such information would be valuable in interpreting the results of field tests.

Objectives.--

a. To determine the influence of soil applications of granular and pelleted herbicide formulations on turbinella oak in the field.

b. To determine the influence of leaching upon the rate and extent of herbicidal action.

Materials and Methods.--The following chart lists the herbicides used and gives the amount applied per acre. Each treatment was leached with one, two, and four inches of water.

Herbicide	Concentration	Lbs. per Acre
Monuron	25% pellets	4, 8, and 16
Fenuron	25% pellets	4, 8, and 16
Urox	22% granular	4, 8, and 16
TBA	25% granular	4, 8, and 16
Fenac	10% granular	4, 8, and 16
2,4-D	10% granular	8, 16, and 32
Silvex	10% granular	8, 16, and 32

These treatments were applied during August of 1959. They were applied to individual bush plots in three replications of a completely randomized block. An area 16 square feet (4 x 4 feet) around the base of each bush was treated. A frame work consisting of galvanized iron (Figure 12) was placed around each bush and the specified aliquot of herbicide and water applied therein.

The water was hauled to the site in a tank truck (kindly supplied by Arizona State University) and pumped out of the tank truck by a pump mounted on the power take-off of an Oliver OC-4 tractor. The water was measured by a water meter (supplied by the Citrus Experiment Station, University of Arizona) on the discharge side of the

pump. The water was sprinkled on the plots through a nozzle to simulate rainfall and aid in dissolving the granular or pelleted herbicides.

It was proposed to take soil samples and run bio-assays to determine the extent of leaching obtained on each herbicide with each amount of water. However, permission could not be obtained to use the originally selected site and the site finally used was too rocky to permit sampling.

Four twigs were marked on each bush by placing red plactic tape one inch from the tip of the twig. This will enable measuring any reduction in growth that may result from the various treatments.

A rain gage was installed at the site.

Results and Discussion.--Preliminary data (Table 17) indicate that fenuron is by far the fastest acting herbicide in the test. An earlier evaluation (not shown) yielded essentially the same information. The fenuron data indicates generally that the action of the chemical was enhanced by the increasing amounts of water.

The TBA treated bushes appeared to be more effectively controlled with the lower amounts of water added after treatment. This may be due to volatility of the herbicide.

Table 17.--Percent apparent kill of turbinella oak on November 11, 1959, after treatment in August of 1959 with various rates of several herbicides and leaching with zero, one, two, or four inches of water. Tempe, Arizona, 1959.

Treatment	Lbs/Acre	Inches of Water			
		0	1	2	4
Monuron	4	1	0	0	0
	8	1	2	0	7
	16	0	0	5	20
Fenuron	4	7	8	10	23
	8	18	72	74	74
	16	52	70	90	98
Urox	4	0	0	0	0
	8	5	0	0	0
	16	0	31	10	33*
TBA	4	40	2	2	5
	8	2	2	0	0
	16	25	22	45	2
Fenac	4	0	0	0	0
	8	0	2	3	0
	16	0	5	0	0
2,4-D	4	0	0	0	0
	8	3	0	0	0
	16	5	0	0	2
Silvex	4	0	0	0	0
	8	0	1	0	0
	16	2	0	3	0
Check		0	0	0	0

* One of the three replications did not receive water.

Figure 12.--Application of water to single bush soil herbicide plots.

Experiment Number 9

Title.--Comparison of soil applied treatments of granular fenac with pelleted fenuron for control of turbinella oak.

Background.--Various soil applied granular and pelleted herbicidal applications have shown some promise for the control of turbinella oak. (See Experiment Number 4.) The sample of fenac arrived too late to be included in the larger experiments.

Reports from the formulator and other investigators indicated that fenac was active as a soil applied herbicide. Since fenuron was one of the most promising herbicides in other tests it was decided to test fenac and fenuron on fire sprouts of turbinella oak.

Objectives.--

a. To test fenac for the control of turbinella oak.

b. To compare fenuron with fenac.

c. To determine the effect of both herbicides on a well established stand of Lehmann's lovegrass.

Methods and Materials.--The treatments consisted of four, eight, and 16 pounds per acre of fenuron and fenac, also a check plot with sub-plots designated as low, medium and high level of treatment. The plot size was 35 x 35 feet arranged into three replications of a split plot experimental design.

Fenuron was applied as 25 percent pellets and the fenac was a 10 percent granular formulation. The applications were made by hand in the manner previously described in Experiment Number 2. The applications were made July 16, 1959, to burn sprouts of turbinella oak.

The experimental area had been burned over and reseeded to Lehmann's lovegrass in June of 1958. An excellent stand of lovegrass covered the area uniformly at the time of treatment.

An evaluation was made of percent apparent kill of both oak and grass in December of 1959. The data was transformed prior to statistical analysis by adding one to each variate and then transforming by arcsin.

Results and Discussion.--Preliminary data (Table 18) show, at the time the evaluations were made, that fenuron was considerably more toxic to both grass and oak than was fenac. The data further show that both herbicides are at least as toxic to the grass as to the oak. It was felt that the figures reflected apparent kill of oak, but actual kill of grass.

The analysis of variance (Appendix Table 10) showed that on both oak and grass fenuron was significantly more toxic than fenac. There was no difference between fenac and the check on oak control, but fenac was significantly toxic to the grass. It should be pointed out that the analysis of variance was performed on transformed data while the data shown here is not transformed. The transformation process served to pull the figures much closer together.

Here again is an example of the rapid action and extensive defoliation of oak which is characteristic of fenuron. Fenuron resulted in excellent apparent kill since these evaluations were made in December when the oak had no opportunity to leaf out after defoliation. It will be most interesting to see the rate and extent of recovery made by these fenuron treated oak plants in the spring.

Fenac is either much slower in action or is relatively much less toxic to oak than is fenuron. Since fenac is related to the benzoic acid herbicides it may posses the slow action and growth inhibition exhibited by the benzoics. Although a direct comparison is not available, the benzoic acids have, in other tests, resulted in considerably more damage to oak over a comparable length of time.

Table 18.--Percent apparent kill of turbinella oak and Lehmann's lovegrass approximately 4.5 months after a July 16, 1959, application of four, eight, and 16 pounds per acre of fenuron or fenac. Tempe, Arizona, 1959.

Treatment	Fenuron			Fenac			Check		
lbs/Acre	4	8	16	4	8	16	0	0	0
Oak	77	87	94	7	10	17	0	0	2
Mean*		86			10			1	
Grass	65	90	98	30	35	28	0	0	2
Mean		85			31			1	

* All means not underlined by the same line differ significantly at the five percent probability level.

Experiment Number 10

Title.--Effect of retreatment timing on control of turbinella oak with 2,4,5-T and silvex.

Background.--When topkilled by fire, chemical or mechanical methods turbinella oak sprouts vigorously and profusely from the crown area of the plant. It has become increasingly doubtful that a single foliage spray of any chemical now being used will kill even a small portion of the treated plants.

Other tests indicate that a high percentage of leaf kill and some stem kill may be obtained within three months after initial spraying. It is possible that retreatment at some interval following initial application may significantly improve the kill of turbinella oak now being obtained.

Objectives.--The objectives of this study are to gather preliminary data on the control of turbinella oak provided by retreatment with phenoxy herbicides. The study is designed to provide information regarding:

a. Effect of retreatment as compared with single treatment.

b. Timing of retreatment.

c. Minimum effective application rate.

d. Comparison of 2,4,5-T and silvex under above conditions.

e. Possible interaction of above factors.

Materials and Methods.--The test contained two herbicides, 2,4,5-T and silvex, each at zero, one, two, and four pounds per acre. These treatments were proposed to be applied in the spring (total of

one treatment), in the spring and fall (total of two treatments), in the spring and spring (total of two treatments) and spring-fall-spring (total of 3 treatments). These applications were made to 25 x 60 foot plots with a 10 foot isolation strip between plots. The plots were arranged into three replications of a randomized block experimental design.

The applications were made with a 25 foot boom attached to an Oliver OC-4 tractor. The gallonage was 20 gallons per acre at 30 pounds pressure and the herbicides were carried in a 1:7 diesel oil in water emulsion.

The following application dates are listed along with pertinent climatological observations.

Application Date - May 5, 1959

a. Clear and sunny - temperature 75 to 80°F - wind up to Ca. 10 miles per hour.

b. Oak growing actively, however, a frost the night before treatment had nipped new growth.

Application Date - September 29, 1959

a. Clear and sunny - temperature 65-70°F - wind 10-12 miles per hour.

b. No observations made on oak.

<u>Results and Discussion</u>.--No data has been taken on this test as yet.

MEETINGS ATTENDED

1. Western Weed Control Conference - Salt Lake City, Utah

   3 days

2. Salt River Water Users' Association - Phoenix, Arizona

   1 day

3. Forest Supervisor's Meeting - Springerville, Arizona

   2 days - participated

4. Extension Range Meeting - Dewey, Arizona

   1 day - participated

5. American Society of Range Management, Arizona Section - Tucson, Arizona

   2 days - participated

LIST OF HERBICIDES

Chemical Name	Abbreviation	Source	Commercial Designation
2,4,5-Trichlorophenoxy acetic acid (PGBE ester)	2,4,5-T	Dow1/	Esteron 245
2,4,5-Trichlorophenoxy acetic acid (Butoxyethanol ester)	2,4,5-T	Amchem2/	Weedone 2,4,5-T
2-(2,4,5-Trichlorophenoxy) propionic acid (PGBE ester)		Dow	Silvex
2,4,5-Trichlorophenoxy acetic acid (PGBE ester Forron formulation)	2,4,5-T Forron	Dow	M-1094
2-(2,4,5-Trichlorophenoxy propionic acid (PGBE ester Forron formulation)	~~2,4,5-TP~~ silvex Forron	Dow	M-1445
Dimethylamine 2,3,6-Trichlorobenzoate	TBA amine	DuPont3/	Tryben 200
2,3,6-Trichlorobenzoic acid (granular)	TBA	DuPont	TBA 25
Polychlorobenzoic acid	PBA	Amchem	Benzac
Dimethylarsinic acid	Cacodylic acid	AS & R4/	--
3-(p-Chlorophenyl)-1,1-Dimethylurea (pelleted)	Monuron	DuPont	Monuron 25% pellets
3-Phenyl-1,1-Dimethylurea	Fenuron	DuPong	Karmex FP
2-Chloro-4,6-bis-(ethylamino)-s-triazine (granular)	Simazine	Geigy5/	Simazine
3-(p-Chlorophenyl)-1,1-Dimethylurea·Trichloroacetate	Urox	G. C.6/	Urox
3-Phenyl-1,1-Dimethylurea·Trichloroacetate	Urab	G. C.	GC·2603
2,4-Dichlorophenoxy acetic acid (PGBE ester)	2,4-D	Dow	Esteron ten-ten

Chemical Name	Abbreviation	Source	Commercial Designation
2,3,6-trichlorophenyl acid amide	Fenac	Amchem	ACP M-906
3-Amino-1,2,4-Triazol	ATA	Amchem	Weedazol
3-Amino-1,2,4-Triazol (liquid formulation)	ATA liquid	Amchem	ACP M-569
4,6-Dinitro-Ortho-secondary Butylphenol	DNBP	Dow	Dow General
Solium Chlorate-Sodium Metaborate	$NaClO_3$	Chipman7/	Chlorax 40
1,1'-ethylene-2,2'-dipryidilium dibromide	FB-2	Chipman	--

1/ Dow Chemical Company, Midland, Michigan

2/ Amchem Products Incorporated, Ambler, Pennsylvania

3/ E. I. du Pont de Nemours and Company Incorporated, Wilmington, Delaware

4/ American Smelting & Refining Company, South Plainfield, New Jersey

5/ Geigy Agricultural Chemicals, Yonkers, New York

6/ General Chemicals Division, Allied Chemical and Dye Corporation, Morristown, New Jersey

7/ Chipman Chemical Company, Bound Brook, New Jersey

Appendix Table 1.--Summary of analyses of variance performed on transformed percent apparent topkill data taken on various dates after treatment of unburned and fire sprouts of turbinella oak with two rates of various herbicides on September 30, 1959, and retreated September 24, 1959. Tempe, Arizona, 1959.

Source	Degrees of Freedom	Mean Square					
		1/59		6/59 1/		9/59	12/59
		Fire Sprouts	Unburned	Fire Sprouts	Unburned	Fire Sprouts	Fire Sprouts
Main Plots	26						
Replications	2	82.5	101.1	115.8	213.6	5.7	236.4
Treatments	8	1934.2**	3002.8**	416.8**	2670.4**	46.9**	3106.4**
Error a	16	82.4	75.8	44.4	92.9	6.8	65.6
Sub-Plots	27						
Level of treatment	1	278.8	813.5**	266.0**	701.5*	80.4**	506.7*
Level x treatment	8	72.8	64.7	43.3	66.6	11.1	89.8
Error b	18	81.7	69.6	21.7	110.5	3.03	73.7

1/ Checks not included in analysis, therefore degrees of freedom involving treatments must be reduced by one or appropriate multiples thereof.

* Variance significant at five percent probability level.

** Variance significant at one percent probability level.

Appendix Table 2.--Summary of analysis of variance performed on transformed percent apparent topkill data taken three months after application of two rates of various herbicides to fire sprouts and unburned oak on March 20, 1959. Tempe, Arizona, 1959.

Source	Degrees of Freedom	Mean Square	
		Fire Sprouts	Unburned
Replications	2	66.4	649.9
Treatments	8	557.4**	1395.5**
Level of treatment	1	347.0	740.0
Treatments x levels	8	98.9	386.6
Error	34	84.6	254.9

** Variance significant at one percent probability level.

Appendix Table 3.--Analysis of variance on estimated topkill of turbinella oak sprayed with three pounds per acre of 2,4,5-T carried in various oil/water emulsion ratios with and without surfactants, Tempe, Arizona, 1959.

Source	Degrees of Freedom	Sum of Squares	Mean Square
Total	59	18945.2	
Replications	3	770.9	257.0
Surfactants	2	445.1	227.5
Oil/water ratios	4	4929.0	1232.2**
No oil vs. oil	(1)	4814.2	4814.2**
5% vs. 10, 20, 40%	(1)	32.6	32.6
10% vs. 20 and 40%	(1)	2.6	2.6
20% vs. 40%	(1)	79.6	79.6
Surfactants x ratios	8	880.5	110.1
Error	42	11919.7	283.8

Appendix Table 4.--Summary of analysis of variance performed on on arcsin transformed data of percent apparent kill of turbinella oak six and 12 months following application of various granular or pelleted herbicides in December of 1958. Tempe, Arizona, 1959.

Source	Degrees of Freedom 6/24/59 Evaluation	Degrees of Freedom 12/3/59 Evaluation	Mean Square 6/24/59 Evaluation	Mean Square 12/3/59 Evaluation
Main Plots	29	26		
Replication	2	2	70.2	76.2
Treatments	9	8	2597.8**	7270.3**
Error a	18	16	96.1	84.3
Sub-Plots	60	54		1823.0**
Level of treatment	2	2	768.7	203.7**
Level x treatment	18	16	159.0	46.3
Error b	40	36	779.5	

** Variance significant at one percent probability level.

Appendix Table 5.--Analysis of variance on data from bio-assay of soil samples taken six and nine months after treatment of turbinella oak plots with various granular and pelleted herbicides.

Source	Degrees of Freedom		Mean Square	
	6/59 Samples	9/59 Samples	6/59 Samples	9/59 Samples
Main Plots	26	26		
Replications	2	2	1162.3	2.25
Treatments	8	8	12202.2**	105.9 **
Error a	16	16	625.7	10.5
Sub-Plots	54	54		
Level of treatment	2	2	11086.9**	37.6**
Level x treatment	16	16	725.3	13.6**
Error b	36	36	556.0	4.0
Sub-Sub-Plots	162	243		
Depth of sampling	2	3	5463.2**	24.6**
Depth x treatment	16	6	1300.6**	7.2**
Depth x level	4	24	435.2	9.7**
D x T x L	32	48	251.4	3.5
Error c	108	162	280.3	2.5

* Significant at five percent probability level.

** Significant at one percent probability level.

Appendix Table 6.--Summary of analysis of variance performed on arcsin transformed data of percent apparent kill of turbinella oak six months following treatment with various pelleted or granular herbicides in July 1959. Tempe, Arizona, 1959.

Source	Degrees of Freedom	Mean Square
Main Plots	26	
Replications	2	107.4
Treatments	8	5334.5**
Error a	16	180.4
Sub-Plots	54	
Levels of treatment	2	3898.6**
Level x treatment	16	179.3*
Error b	36	72.5

* Significant at five percent probability level.

** Significant at one percent probability level.

Appendix Table 7.--Summary of analysis of variance on fuel moisture of turbinella oak twigs sampled 110 days after treatment with various herbicides or dessicants. Tempe, Arizona, 1959.

Source	Degrees of Freedom	Mean Square
Replications	3	69.0
Treatments	5	729.0**
Level of treatment	1	243.0**
Treatment x level	5	22.0
Error	33	27.5

** Significant at one percent probability level.

Appendix Table 8.--Summary of analysis of variance of percent apparent topkill of turbinella oak on 1/8/60 after treatment at various times with two, four, or eight pounds per acre of 2,4,5-T or silvex. Tempe, Arizona, 1959.

Source	Degrees of Freedom	Mean Square
Replications	4	424.75
Date of treatment	7	494.74
Treatment	1	1679.1*
Level of treatment	3	32097.2**
Date x treatment	7	225.15
Date x level	21	391.02
Treatment x level	3	421.9
D x T x L	21	134.2
Error	252	296.21

* Significant at five percent probability level.

** Significant at one percent probability level.

Appendix Table 9.--Summary of analysis of variance on December 2, 1959, apparent kill data after treatment of turbinella oak in the spring, fall, or spring and fall with two pounds per acre of 2,4,5-T or TBA. Tempe, Arizona, 1959.

Source	Degrees of Freedom	Mean Square
Replications	5	141.6
Treatments	6	3634.3**
Error	30	213.1

** Variance significant at one percent probability level.

Appendix Table 10.--Summary of analysis of variance on percent apparent kill of turbinella oak and Lehmann's lovegrass approximately 4.5 months after treatment with four, eight, and 16 pounds per acre of fenuron or fenac. Tempe, Arizona, 1959.

Source	Degrees of Freedom	Mean Square oak	Mean Square lovegrass
Treatment	2	10195.0*	9540.0*
Replications	2	4.0	438.3
Error a	4	83.2	828.2
Level of treatment	2	345.4**	299.1**
Level x treatment	4	1.41	256.0**
Error b	12	22.36	19.82

* Variance significant at five percent probability level.

** Variance significant at one percent probability level.